S T A T E O F T E N N E S S E E

January 1, 2015

GENERAL NOTES

FOR

POLYMER MODIFIED ASPHALT
REJUVENATING SCRUB SEAL

Description

The work shall consist of, but not limited to, furnishing all labor, materials, equipment and transportation for the application of the polymer modified asphalt rejuvenating scrub seal innerlayer. All ingredients shall be properly proportioned, mixed, and spread on the paved surface in accordance with this Specification and as directed by the Engineer.

Materials

Aggregate

The cover material for the seal shall be an approved crushed stone meeting the gradation requirements for Size No. 8 or 89 conforming to Standard Specification Subsection 903.22. The aggregate shall be washed after processing so that the amount of material finer than the No. 200 screen does not exceed 1.5%. Gradations are to be verified by TDOT prior to use. Testing shall be accomplished by referencing the Materials and Tests Standard Operations Procedure (SOP 1-1) for surface treatment aggregate at the frequencies established or as identified in the **Stockpile Site** section of this provision. The moisture content of the aggregate shall not exceed that at a SSD condition at the time of placement.

If the scrub seal is to be utilized as an innerlayer or for a riding surface of a low volume route, ADT less than or equal to 1000, the aggregate shall meet the quality requirements found in ASTM D692. Aggregate for use as the final riding surface on routes with an ADT greater than 1000 shall meet the quality requirements identified in Standard Specification, Subsection 903.24, for polish resistant aggregate.

The maximum amount of flat and elongated aggregate with a ratio of 3:1 shall not exceed 18% as determined by ASTM D4791.

If material is used whose tests indicate that the amount passing the No. 200 is greater than 1.5%, the surface treatment will not be accepted and the contractor shall place another scrub seal layer on top of the previous layer's lot that was represented by the failing sample.

Emulsion

The asphalt emulsion shall be a polymer modified asphalt emulsion with a rejuvenating agent, meeting the following requirements:

Property	Test Procedure (AASHTO)	Specification (min)	(max)
Emulsion Properties			
Viscosity, Saybolt-Furol, @ 77°F, SFS	T59	50	350
Storage, 24 hour, %	T59		1
Oil Distillate, %	T59		0.5
Sieve Test, %	T59		0.1
Residue by Distillation(1) @ 350°F, %	T59	60	
Residue Properties From Distillation	T59		
Penetration @ 4°C , 200g weight, 60 sec	T49	30	
Residue Properties From Low Temp Evaporation	PP72-11, Procedure B		
Dynamic Shear, G*/sin δ @ 64°C, kPa	T315	Report Only	
Polymer Properties(2)			
Swelling in rejuvenating agent, % max weight increase: 48	ASTM D471		40%
Tensile Strength (psi)	ASTM D412a	800	
Glass Transition Temperature (T_g) – Midpoint by DSC (°C)	ASTM D7426	0	
Latex Density at 23°C (g/cm^3)	ASTM D6937	1.00	1.05
Latex pH	ASTM E70	6.0	8.0
Test on Rejuvenating Agent			
Flash Point, COC,°F	T48	380	
Viscosity, 140°F, CST	201	50	175
Saturate, % by wt	ASTM D2007		30
Asphaltenes	ASTM D2007		1.0
Test on Residue from RTFO			
Weight change, %			6.5
Viscosity Ratio			3

1. Exception to AASHTO T59: Bring the temperature on the lower thermometer slowly to 350°F plus or minus 10°F. Maintain this temperature for 20 minutes. Complete the total distillation in 60 plus or minus 5 minutes.
2. For modifications for Polymer Properties testing, refer to Appendix A Test Modifications.
3. The emulsion supplier shall receive quarterly certificates of analysis from both the polymer and rejuvenating agency manufacturers. The COAs will be provided to the agency upon request.

Material Certifications and Testing
The emulsion manufacturer, through the contractor, shall submit to the Department certification that the emulsion meets the specification. The manufacturer of the Rejuvenating Agent, through the emulsion supplier and the contractor, shall submit to the Department test results on the recycling agent and certification that the recycling agent meets the required specifications. The Laboratory shall be certified in Tennessee and comply with TDOT SOP 3-2, Emulsified Asphalt Certified Supplier Requirements.

Prior to work, the supplier shall submit samples of the finished emulsion and rejuvenating agent to the Division of Materials and Tests. The Engineer may request samples of the rejuvenator and the emulsion for testing during the life of the project.

Construction Requirements

Preparation
The work shall be done in the following order: Prepare the pavement surface; apply the polymer modified asphaltic rejuvenating emulsion and scrub the applied emulsion with a scrub broom as specified herein; apply and roll the aggregate; power broom the aggregate after the emulsion has cured and if necessary with a secondary broom when required as determined by the Engineer; and sweep up and dispose of excess aggregate. Excess aggregate shall be removed from the project unless otherwise approved or directed by the Engineer.

Prior to the scrub seal operation, the Contractor shall remove any and all vegetation within the limits of the scrub seal installation. The use of herbicides will be allowed at the discretion of the Engineer.

If used, the herbicide shall be applied at least 10 days prior to the scrub seal operation, or as directed by the manufacturer of the approved herbicide. The application of the herbicide shall be performed in accordance with all applicable regulations. Any and all fines or clean-up costs for unlawful misuse or discarding of herbicides shall be the sole responsibility of the Contractor. Mixtures and spread rates for the herbicides shall be determined by the manufacturer's specifications. Wash down of equipment or discarding of herbicides shall not enter the catch basins or positive drainage facilities.

Prior to the scrub seal operation, the Contractor shall remove all existing thermoplastic striping, thermoplastic legends and raised pavement markers within the scrub seal limits. When removing the raised pavement markers, the Contractor shall remove excessive adhesive left on the pavement caused from the removal of raised pavement markers. Removal shall be performed to the satisfaction of the Engineer.

Prior to application, all drop inlets, manholes, utility valve covers, monument covers, and any identified areas shall be protected from the Contractor's scrub seal operations by applying and securing protective cover over the exposed facilities. Other methods may be used if approved by the Engineer. Curb and gutter and private entrances shall be

protected from emulsion overspray. All traces of protective cover, residual emulsion and aggregate shall be removed from covered objects after the application of the scrub seal and/or prior to the final inspection of the project.

Immediately prior to the scrub sealing operations, the Contractor shall sweep the entire pavement surface.

Application

Curb and gutter, identified concrete surfaces, and private entrances shall be protected from emulsion overspray. Hand brooming may be necessary to assure that the surface treatment is uniform along the edges of gutter or curb faces. Where no curb or gutter exists, the scrub seal shall be applied from edge of pavement to edge of pavement or as identified in the typical sections of the plans. The edges of the scrub seal application shall be maintained in a neat and uniform line.

The asphalt distributor should not be permitted to start spraying until the brooms, aggregate spreader and loaded trucks are in line and ready to apply the cover aggregate, and pneumatic-tire rollers are ready to begin rolling the cover aggregate as soon as it has been spread.

When constructing a scrub seal in half-road widths a strip of uncovered asphalt emulsion 3 to 4 inches wide shall be left along the inside edge when spraying the first half-width, to create an overlap when spraying the second half width. Other methods may be used if approved by the Engineer.

To construct transverse joints, the asphalt distributor shall start spraying and should stop spraying (if ending at a sensitive point) on a sufficient length of secured building paper, felt, or other suitable material placed transversely across the roadway.

The polymer modified rejuvenating emulsion shall be applied at a temperature of 140 to 180 °F only when the ambient temperature is 60°F and rising. The emulsion shall not be placed if the forecast ambient temperature during a twenty four-hour curing period is expected to be below 50 °F.

The emulsion shall be applied undiluted with a distributor truck at a rate of 0.25 to 0.35 (gal/yd^2). If the emulsion is being placed on a milled surface, the application rate shall be 0.30 to 0.40 (gal/yd^2). The actual emulsion application rate shall be determined from the surface demands and aggregate used. This target rate shall be determined with a test strip in the presence of the Engineer and manufacturer's representative if necessary.

During the test strip, the distributor shall be calibrated by applying asphalt emulsion for a minimum 300 feet continuous section. The amount of material distributed shall be within 5% of the intended application rate and shall be verified by use of the strapping stick as supplied by the equipment manufacturer. Neither a visual gauge indicating volume nor the computer readout shall be used as a calibration method.

In small areas, the emulsion may be applied with the hand wand to minimize overlap. Spread rates of emulsion shall be verified daily by the contractor in the presence of the Engineer. The strapping stick as supplied by the equipment manufacturer shall be utilized to measure the gallons of emulsion used.

Immediately following the application of the emulsion to the road surface, the material shall be scrubbed with a scrub broom for the purpose of forcing the emulsion into the existing surface and distributing the emulsion evenly transversely and over variable road surface cracks and contours.

The application of the polymer modified asphaltic rejuvenating emulsion and scrub broom operation shall cease 40 feet prior to the end of the application. The remaining polymer modified asphaltic rejuvenating emulsion shall be drug out by the scrub broom, and the remaining emulsified material required to complete the pass shall be applied only by the distributor truck, at the specified rate if needed.

Immediately following the scrubbing of emulsion, cover aggregate shall be applied and spread evenly by a mechanical spreader at an application rate of 18 to 25 pounds per square yard. The actual aggregate application rate shall be as required by the surface demands and the emulsion used. The rate shall be adjusted, within the specified limit, so that no “bleed through” occurs during rolling. The application rate of the aggregate shall be determined with a test strip in the presence of the Engineer.

During the first each half day production (AM and PM) and daily thereafter at start-up, the application rate of the aggregate shall be verified by the contractor in the presence of the Department to assure that the appropriate target application rate is applied. This frequency may be reduced or increased depending on application consistency and as determined by the Engineer. For spread rate verification place a tarp or other suitable material on the surface to be treated. The aggregate spreader shall make a pass over the tarp at the target speed. The aggregate on the tarp shall be carefully collected and weighed. This applied or measured weight shall be compared to the target weight using the target rate determined from the test strip.

If the mean difference in the target weight and the actual measured weight is over 2.5 pounds per square yard, the aggregate spreader shall be adjusted such that the spread rate is within the above tolerance. The above procedure shall be repeated until the spread rate is consistently within the allowable tolerance.

If at any point during production, excessive aggregate is noted, the aggregate application rate should be re-verified and the spread rate adjusted. The intent is to minimize the amount of excess aggregate. Excess aggregate removed from the roadway surface after brooming shall be removed from the job site and should not be reused in the aggregate operation. All deficient areas shall be covered by additional material.

A minimum of two self-propelled pneumatic-tired rollers shall be used for the required rolling of the aggregate. The pneumatic-tired rollers shall be in good working condition

and actively rolling at all times during the scrub seal operation. The pneumatic-tired rollers shall be operated in such a manner to properly seat and prevent the dislodging of newly applied aggregate. Depending on the speed of the Chip Seal operation and the width of coverage, additional rollers may be required. At no time shall the rollers travel more than 10 mph.

Power sweeping must be done before the end of the day after scrub seal operations to remove any excess loose aggregate and prepare the roadway for temporary striping. A second power sweeping may be directed by the Engineer on the previous days seal operation to remove any loose aggregate. Power sweeping must be done prior to any additional application of temporary striping. The contractor shall control excessive dust as directed by the engineer.

For inner-layer applications the scrub seal shall be sufficiently cured prior to placing a bituminous overlay, micro-surfacing or other asphalt surface treatments. The work shall be staged such that any scrub seal inner-layer placed shall be covered by the succeeding surface treatment within 72 hours or as approved by the Engineer.

Do not allow traffic on the treatment until it has cured sufficiently. Any failures occurring shall be reworked to the satisfaction of the Engineer at the contractors' expense.

The status of being cured shall be determined by the ability to sweep all loose aggregate from the surface without removing any aggregate adhered to the bituminous emulsion.

Test Strip
Prior to the beginning of the project, the contractor is required to perform a test strip in a suitable area to assure the materials, contractor personnel and equipment are capable to produce a satisfactory Rejuvenating Scrub Seal. The location for the test strip shall be approved by the Engineer. Target rates of application and the speed and RPM of equipment shall be determined.

Stockpile Sites
Sites for stockpiles of materials shall be grubbed, cleaned, and approved prior to storing the aggregates. The ground shall be firm, smooth, and well drained. Stockpiles shall be checked for gradation prior to its incorporation into the work. As stockpiles are replenished, they shall be separated daily to verify daily gradations.

Equipment
The following equipment shall be used for the scrub-seal operations:

Asphalt Distributor
The asphalt distributor for application of the emulsion shall be fully operational, have a full circulation spray bar that is adjustable to at least sixteen feet wide in two feet increments, and be capable of heating and circulating the emulsion simultaneously. It must have a computerized rate control for adjusting and controlling the application from the cab within 0.01 gallons per square yard increments. The distributor shall also be

equipped with a volume measuring device and a thermometer for measuring the emulsion temperature in the tank. Nozzles on the distributor bar shall be clean, properly oriented, fully operational, and of the size suggested by the manufacturer to apply the intended application rate.

During the test strip, the distributor shall be calibrated by applying asphalt emulsion for a minimum 300 feet continuous section. The amount of material distributed shall be within 5% of the intended application rate at the intended width to be used on the project and shall be verified by use of the strapping stick as supplied by the equipment manufacturer. Neither a visual gauge indicating volume nor the computer readout shall be used as a calibration method. Alternate calibration methods may be utilized as approved by the Department.

Scrub Broom
A scrub broom as identified in Exhibit "A" within this provision shall be used to scrub the emulsion.

The scrub broom frame shall be constructed of metal. The scrub broom shall be attached to and pulled by the distributor truck. The scrub broom must be equipped with a means of raising and lowering the scrub broom at desired points. It shall be towable in the elevated position. The broom assembly shall be such that it will maintain a constant head of emulsion without sweeping the emulsion off the roadway surface.

The main body of the scrub broom shall have a frame size of 16 feet x 8 feet. The nearest and furthest members, paralleling the back of the spreader truck, and diagonal members shall be equipped with street brooms. The leading member and the trailing member shall have broom heads angled at 10° to 15° off the centerline of the supporting member. The diagonal members shall have broom heads attached in line with the centerline of the supporting member. Each individual street broom attached to the scrub broom assembly shall be 3.5 inches wide x 6.5 inches high x 16 inches long and have uniform, stiff nylon bristles. Bristle height is to be maintained at a minimum of five inches. The scrub broom shall be equipped with hinged wing assemblies attached to the main body not to exceed 4.5 feet per side, with diagonals and equipped with street brooms. The purpose of the maximum rigid frame width and the hinged wing extensions is not only for maximum width of 16 feet but to maintain the scrubbing process evenly as contours and cross-sections change across the existing road surface.

Aggregate Spreader
A self-propelled aggregate spreader with front discharge that can consistently and evenly distribute aggregate shall be used. The aggregate spreader shall be calibrated in the presence of the Engineer off site using aggregate intended to be used on the project. An acceptable procedure may include:

Place two square tarps (typically supplied with the spreader), that measure 1.0 yd^2, adjacent to each other and in front of the spreader. Allow room for the spreader to reach operating speed and discharge aggregate while passing over the tarps. Carefully collect

each tarp at the corners and using an approved scale (typically supplied with the spreader) determine the weight of the aggregate on each tarp. The weight should not vary by more than 5% between tarps.

Speed and gate openings shall be determined to apply the desired range of aggregate spread rates as established here-in.

Rollers
A minimum of two (2) self propelled pneumatic tire rollers weighing at least five (5) tons each shall be used on the project. Tire pressure shall be specified by the manufacturer and shall not vary more than plus or minus 5 pounds per square inch.

Power Broom
Two (2) mechanically powered kick-brooms or vacuum type brooms that are in good dependable condition shall be used.

Method of Measurement

The Polymer Modified Asphalt Rejuvenating Scrub Seal shall be measured as a system by the Department by the square yard complete in place as follows:

405-03.01	PM REJUVENATING SCRUB SEAL	S.Y.

Basis of Payment

The Polymer Modified Asphalt Rejuvenating Scrub Seal, measured as prescribed above, will be paid for at the contract bid price per, which shall be full compensation for furnishing all labor and materials, equipment, surface preparation, application, rate verifications, rolling, pre-sweeping, post-sweeping, protection, and all incidentals necessary to complete the work in an acceptable manner as described here-in.

Appendix A Test Modifications

ASTM D471 Standard Test Method for Rubber Property-Effect of Liquids: Modifications for Polymer Testing, Resistance to Swelling:

1. Using a syringe, place 0.8 gm of latex into an 18 mm diameter DSR mold.
2. Allow the sample to dry at ambient lab conditions (air conditioned) on the bench for 72 hours. Sample should be easily removable from the mold.
3. Take the "button" out of the mold and place the sample into a forced air oven at 40°C (104°F) for 48 hours (on release paper). If at the end of the ambient dry, the sample sticks to the mold, place it into the oven and check it after 1-2 hours.
4. After 48 hours, cool and weigh the sample to the nearest 0.0001 gram and record the weight.
5. Put ½ inch of Rejuvenating Agent into a 3 oz penetration tin.
6. Place the "button" on the Rejuvenating Agent, and add another ½ inch of Rejuvenating Agent, so that the "button" is covered.
7. Put the cap on the penetration tin and place it into the 40°C oven for 48 hours.
8. Remove the "button from the Rejuvenating Agent, blot surface of the "button" to remove excess Rejuvenating Agent, cool the "button" to room temperature and weigh it.
9. Calculate weight gain of the "button", express as %.

ASTM D412A Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension: Modifications

1. To prepare the polymer film, dilute the waterborne polymer to 40% Total Solids Content and pour 57 g into a Teflon or silicone release mold of dimensions 7''x 7'' x ¼''.
2. Allow to dry at 23°C (73 °F) and 50% RH (controlled conditions) for 7 – 10 days total time, during which time the film should be flipped around once, preferably after 3 or 4 days. The film should be transparent in the end.
3. To drive out any residual water, place the film in an oven at 50°C for 30 min. Dried film thickness should be 25 mil +- 5 mils. Discard films <20 mil.
4. Cut out dumbbell-shaped test specimens of dimension 75 mm total length, 25 mm mid-section (L) and 4 mm width of mid-section.
5. Grip in Instron machine with gap size 1 inch, use 8 inch/min cross-head speed.

ASTM D7426 Standard Test Method for Assignment of the DSC Procedure for Determining Tg of a Polymer or an Elastomeric Compound Modifications

Use between 3 – 30 mg dry polymer. Instrument used is TA Q2000 Differential Scanning Calorimeter (DSC). Heating rate is20°C/min.

ASTM D6937 Standard Test Method for Determining Density of Emulsified Asphalt: Modifications

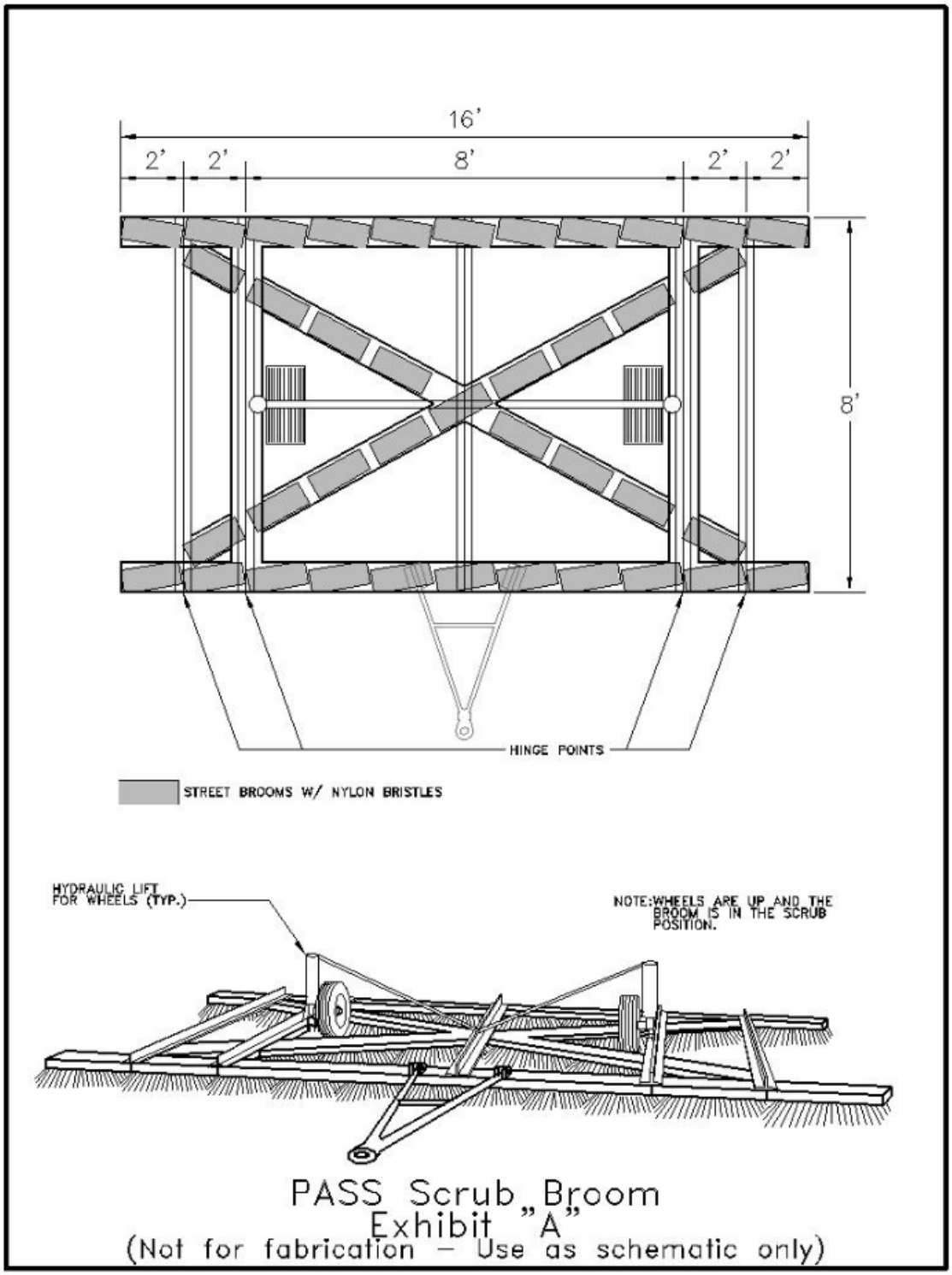
Replace "Emulsified Asphalt" with "Latex" in text of test method. The testing temperature used should be 25 +/- 3°C. The calculation should be as follows:

Calculation:
$D = (W_f - W_t) * 0.1$
S.G. = D / 8.337
Where: W_f = Weight of filled cup (g)
W_t = Weight of empty cup (g)

ASTM E70 Standard Test Method for pH of Aqueous Solutions with the Glass Electrode: Modifications

1. A pH meter with automatic temperature measurement should be used in the evaluation with a calomel cell assembly or combination electrode. Calibration should be made using the procedure with the pH meter, according to ASTM method, prior to testing the pH of the latex. The procedure for measuring pH of the latex should be as follows:
   (a) Place the electrode and probe into the dispersion that is to be measured and swirl the sample cup or beaker gently. (You may also use the probe in a stirring motion.)
   (b) Wait for the reading to stabilize (usually less than a minute) and read/record this value. Note the temperature if not utilizing an ATC probe.
   (c) Take the Electrode and ATC probes from the sample and rinse thoroughly with de-ionized water. Pat dry and place back into appropriate solution recommended by electrode manufacturer for storage.

EXHIBIT "A"


16'
2'
2'
8'
2'
2'
8'
HINGE POINTS
STREET BROOMS W/ NYLON BRISTLES
HYDRAULIC LIFT FOR WHEELS (TYP.)
NOTE:WHEELS ARE UP AND THE BROOM IS IN THE SCRUB POSITION.
PASS Scrub Broom
Exhibit "A"
(Not for fabrication – Use as schematic only)